

REMARKS

Claims 93-117 are pending in the present application. Reconsideration and allowance of pending claims 93-117 in view of the following remarks are requested.

The Examiner has rejected claims 93-117 under 35 USC §103(a) as being unpatentable over U.S. patent number 5,792,706 to Michael et al. ("Michael") in view of U.S. patent number 6,040,248 to Chen et al. ("Chen"). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by independent claims 93 and 105, is patentably distinguishable over Michael and Chen.

The present invention, as defined by independent claim 93, teaches, among other things, "depositing a first hard mask on said first insulating layer," and "forming a first air gap, a second air gap, and a support pillar in said first hard mask and said first insulating layer, said support pillar being situated between said first air gap and said second air gap." As disclosed in the present application, the support pillar can be appropriately situated adjacent to an interconnect line in a first patterned layer of conductive material to increase the mechanical strength and thermal conductivity of the interconnect line. Also, by appropriately controlling the size and shape of the first and second air gaps formed in the hard mask, the size and shape of the support pillar formed between the first and second air gaps in the first insulating layer can be controlled to achieve a desired increase in mechanical strength and thermal conductivity of an adjacent interconnect line.

In addition, as disclosed in the present application, the hard mask is utilized during etch and clean steps in transferring an air gap pattern to the first insulating layer to

precisely determine the location of the first and second air gaps. Thus, the present invention advantageously achieves a flexible interconnect structure that includes first and second air gaps to provide reduced inter-layer and/or intra-layer parasitic capacitance and a support pillar having an appropriate size and shape to increase the mechanical strength and thermal conductivity of an adjacent interconnect line.

Moreover, independent claim 105 of the present application teaches, among other things, “depositing a second insulating layer over said first insulating layer,” “depositing a first hard mask on said second insulating layer,” and “forming a first air gap, a second air gap, and a support pillar in said first hard mask, said second insulating layer, and said first insulating layer, said support pillar being situated between said first air gap and said second air gap.” As disclosed in the present application, by utilizing first and second insulating layers, the present invention achieves a flexible interconnect structure that can be advantageously adapted to satisfy the requirements of specific applications. For example, the first insulating layer may be a gap fill silicon dioxide layer that can be deposited by a high-density plasma chemical vapor deposition process, while the second insulating layer may be a bulk silicon dioxide layer that may be deposited by a plasma-enhanced chemical vapor deposition process. By way of further example, the first insulating layer may comprise a material having a low dielectric constant and the second insulating layer may comprise an oxide. The present invention, as defined by independent claim 105, also includes the advantages of independent claim 93 discussed above.

In contrast to the present invention as defined by independent claims 93 and 105, Michael does not teach, disclose, or suggest depositing a first hard mask on a first insulating layer and forming first and second air gaps and a support pillar in the first hard mask and first insulating layer, where the support pillar is situated between the first and second air gaps. Michael specifically discloses removing portions of first dielectric 20 to form air gap trenches 26 in first dielectric 20, where air gap trenches 26 are preferably formed at spaced intervals across first dielectric 20. See, for example, column 6, lines 12-15 and Figures 5-7 of Michael. In one embodiment, Michael discloses placing air gap trenches 26 indiscriminately with respect to first interconnect lines 11. See, for example, column 6, lines 33-42 and Figure 6 of Michael. However, Michael does not teach, disclose, or suggest forming a support pillar between air gap trenches 26. In fact, Michael does not even mention a support pillar or forming and utilizing air gap trenches 26 to increase mechanical strength and thermal conductivity of first interconnect lines 11.

Furthermore, by placing air gap trenches 26 indiscriminately with respect to first interconnect lines 11, Michael teaches away from forming a support pillar between adjacent air gap trenches to increasing the mechanical strength and thermal conductivity of a particular interconnect line. Also, Michael does not teach, disclose, or suggest forming a hard mask over first dielectric 20. Moreover, Michael does not teach, disclose, or suggest utilizing a low-k dielectric for first dielectric 20. Michael specifically discloses utilizing a TEOS base oxide for first dielectric 20 to achieve improved step

coverage and avoid formation of voids that can occur between adjacent lines when utilizing silane based oxides. See, for example, Michael, column 5, lines 53-62.

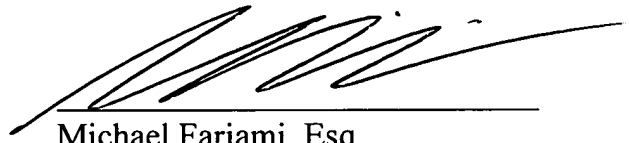
In contrast to the present invention as defined by independent claims 93 and 105, Chen does not teach, disclose, or suggest depositing a first hard mask on a first insulating layer and forming first and second air gaps and a support pillar in the first hard mask and first insulating layer, where the support pillar is situated between the first and second air gaps. Chen specifically discloses a method for etching contact/via openings in organic dielectric layers by patterning silicon oxide layer 26 by photoresist layer 28 to define contact opening 30. See, for example, column 4, lines 4-8 and Figure 2a of Chen. In Chen, photoresist pattern 28 is used to form a silicon oxide hardmask, which is then utilized to etch a contact opening in organic layer 24. See, for example, Chen, column 4, lines 6-9. However, Chen does not teach, disclose, or suggest forming air gaps and a support pillar in the hard mask and organic layer 24 and sealing the air gaps.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by independent claims 93 and 105, is not suggested, disclosed, or taught by Michael and Chen. As discussed above, independent claims 93 and 105 are patentably distinguishable over Michael and Chen and, as such, claims 94-104 depending from independent claim 93 and claims 106-117 depending from independent claim 105 are, *a fortiori*, also patentably distinguishable over Michael and Chen for at least the reasons presented above and also for additional limitations contained in each dependent claim.

Based on the foregoing reasons, the present invention, as defined by independent claims 93 and 105 and claims depending therefrom, is patentably distinguishable over the art cited by the Examiner. Thus, claims 93-117 pending in the present application are patentably distinguishable over the art cited by the Examiner. As such, and for all the foregoing reasons, an early allowance of claims 93-117 pending in the present application is respectfully requested.

Respectfully Submitted,
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